CSCE 411: Design and Analysis of Algorithms

Fun Problems

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Fun Problem #1: Mystery Algorithm

What value of r is returned? What is the running time of this algorithm?

Algorithm 1: MYSTERY-ALGORITHM (n)

Input: Integer n
Output: The value of r

```
1 r ← 0
2 for i ← 1 to n do
3 |   for j ← i to n do
4 |   |   r ← r + j
5 return r
```

Fun Problem #2: Is n a Power of 2?

Given a positive integer n, write an algorithm that determines whether n is a power of 2.

What is the complexity of your algorithm?

Fun Problem #3: The Asymptotic Growth of Fraud

To standardize criminal sentences for fraud, U.S. judges use a point function mapping dollars stolen to sentencing level increases. For example, a fraud loss of $\$500,000$ will result in an sentence level increase of $+12$. **What function best describes the asymptotic growth of the level of punishment with the amount of money stolen? Justify your answer.**

Federal Sentencing Guidelines for Fraud (2016)

Loss (apply the greatest)	**Increase in level**
$6,500 or less	no increase
More than $6,500	add 2
More than $15,000	add 4
More than $40,000	add 6
More than $95,000	add 8
More than $150,000	add 10
More than $250,000	add 12
More than $550,000	add 14
More than $1,500,000	add 16
More than $3,500,000	add 18
More than $9,500,000	add 20
More than $25,000,000	add 22
More than $65,000,000	add 24
More than $150,000,000	add 26
More than $250,000,00	add 28
More than $550,000,000	add 30

Fun Problem #4: The Guessing Game

In this game, Player 1 thinks of a number in the range 1 to n. Player 2's objective is to guess the secret number k, where $1 \leq n$, selected by Player 1. Each time Player 2 makes a guess, Player 1 states whether the guess is correct, higher than the selected number k, or lower than the selected number k.

- What is the optimal strategy if n is known? For example, Player 2 knows that Player 1 is selecting a secret number k between 1 and 100, where n is 100.
- What is a good strategy if n is not known? That is, Player 2 has no idea of the range of numbers for selecting the secret number k.

Fun Problem #5: The Streets of Aggieville

The young mayor (Class of 2017) of Aggieville has made all of the streets one-way. Mayor Millennial, as she's affectionately called, contends that there is a way to drive legally from any intersection in the city to any other intersection, but the opposing residents (the 2-percenters!) are not convinced.

(a) Formulate this problem graph-theoretically. That is, show how the problem can be mapped to a graph $G = (V, E)$. Clearly, state the meaning of the vertices V and the edges E in the graph. What problem are you trying to solve with the graph?

(b) Given the graph G from part (a), give a linear time ($O(|V| + |E|)$) algorithm that determines whether it is possible to drive legally from any intersection to any other intersection in the city.